



IAW AFD

Attorney's Docket No. 67,200-630

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Chao-Yuan Su

Group Art Unit: 1756

Serial No.: 10/051,906

Examiner: John Ruggles

Filed: Jan. 6, 2002

For: A Method of Forming A Solder Ball Using A Thermally Stable Resinous Protective Layer

Commissioner for Patents  
Alexandria, VA 22313

TRANSMITTAL OF **REVISED** APPEAL BRIEF (PATENT APPLICATION-37 CFR 192)

1. Transmitted herewith, in triplicate, is the APPEAL BRIEF in this application, with respect to the Notice of Appeal filed on July 6, 2004.

NOTE: "The Appellant shall, within 2 months from the date of the notice of appeal under § 1.191(a) or within the time allowed for response to the action appealed from, if such time is later, file a brief in "triplicate", 37 C.F.R. 1.192(a) [emphasis added].

2. STATUS OF APPLICANT

This application is on behalf of:

X other than a small entity.  
\_\_\_ a small entity.

A verified statement:

\_\_\_ is attached.  
\_\_\_ was already filed.

3. FEE FOR FILING APPEAL BRIEF

Pursuant to 37 CFR 1.17(f), the fee for filing the Appeal Brief is:

\_\_\_ small entity \$170.00  
X other than a small entity \$340.00

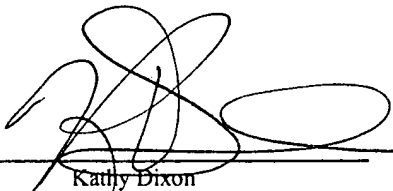
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Kathy Dixon

Dated: Dec. 1, 2004

4. EXTENSION OF TERM

NOTE: The time periods set forth in 37 CFR 1.192(a) are subject to the provision of 37 CFR 1.136 for patent applications. 37 CFR 1.191(d). See also Notice of November 5, 1985 (1060 O.G. 27).

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136 apply:

(complete (a) or (b), as applicable)

- (a) ☐ Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d) for the total number of months checked below:

	Extension (months)	Fee for other than small entity	Fee for small entity
<input type="checkbox"/>	one month	\$ 110.00	\$ 55.00
<input type="checkbox"/>	two months	\$ 430.00	\$215.00
<input type="checkbox"/>	three months	\$ 980.00	\$490.00
<input type="checkbox"/>	four months	\$1,530.00	\$765.00

Fee: \$

If an additional extension of time is required, please consider this a petition therefor.

(check and complete the next item, if applicable)

- ☐ An extension for \_\_\_\_\_ months has already been secured, and the fee paid therefor of \$\_\_\_\_\_ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request: \$

or

- (b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

5. TOTAL FEE DUE

The total fee due is:

Appeal Brief Fee: \$ 00  
Extension fee (if any) \$ \_\_\_\_\_

TOTAL FEE DUE: \$ 00

6. FEE PAYMENT

\_\_\_\_ Attached is a Credit Card Payment Form for the sum of \$ 00

A duplicate copy of this transmittal is attached.

7. FEE DEFICIENCY

NOTE: If there is a fee deficiency and there is no authorization to charge an account, additional fees are necessary to cover the additional time consumed in making up the original deficiency. If the maximum six-month period has expired before the deficiency is noted and corrected, the application is held abandoned. In those instances where authorization to charge is included, processing delays are encountered in returning the papers to the PTO Finance Branch in order to apply these charges prior to action on the cases. Authorization to charge the deposit account for any fee deficiency should be checked. See the Notice of April 7, 1986, 1065 O.G. 31-33.

X If any additional extension and/or fee is required, this is a request therefor  
to charge Deposit Account No. 50-0484

And/Or

X If any additional fee for claims is required, please charge Deposit Account No.  
50-0484



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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**  
**BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

APPELLANTS: Chao-Yuan Su

Group Art Unit: 1756

Serial No.: 10/051,906

Examiner: John Ruggles

Filed: 01/16/2002

Notification of Non-Compliance  
Dated: 11/16/2004

For: A METHOD OF FORMING A SOLDER BALL USING A THERMALLY  
STABLE RESINOUS PROTECTIVE LAYER

Attorney Docket No.: 67,200-630

**EXPRESS MAIL CERTIFICATE**

"Express Mail" label number EV 305 399 469 US  
Date of Deposit Dec. 1, 2004

I hereby certify that this paper in triplicate is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR §1.10 on the date indicated above and is addressed to: Mail Stop: Appeal, Commissioner for Patents, Alexandria, Va. 22313-1450

  
Kathy Dixon

**REVISED APPEAL BRIEF**

Commissioner for Patents  
Alexandria, VA 22313-1450

Sir:

APPELLANTS appeal in the captioned application from the Examiner's final rejection, mailed 4/06/2004, of claims 1-4, 8, 10-19, and 21-24 under 35 USC § 103.

It is urged that Examiners final rejection be reversed and that all the claims currently pending be allowed.

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(1) **REAL PARTY IN INTEREST**

The real party in interest in the present appeal is the recorded Assignee, Taiwan Semiconductor Manufacturing Company, Ltd.

(2) **RELATED APPEALS AND INTERFERENCES**

There are no other appeals or interferences that are known to the Appellant, the Appellant's legal representative, or the assignee.

(3) **STATUS OF CLAIMS**

Claims 1-4, 8, 10-19, and 21-24 are pending in the application.

Claims 5-7, 9, and 20 have been cancelled.

Claims 1-4, 8, 10-19, and 21-24 stand rejected.

APPELLANTS appeal from the rejection of claims 1-4, 8, 10-19, and 21-24.

(4) **STATUS OF AMENDMENTS**

A Request for Reconsideration from Final Rejection was submitted by APPELLANTS on or about 06/03/2004 including proposed amendments.

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An Advisory Action from the Examiner was mailed on 06/22/2003 refusing entry of the proposed amendments citing new objections to the proposed amendments and requiring further changes in the Specification and claims.

A Supplemental Amendment was submitted by APPELLANTS on 09/03/2004 together with an Appeal brief including amendments as required/suggested by Examiner to correct errors and remove issues on Appeal.

Examiner mailed an Advisory Action on 11/16/2004 indicating entry of the proposed Amendments filed on 09/03/2004 together with a Notice of Non-Compliance under 37 CFR 1.192(c).

APPELLANTS hereby submit an Amended Appeal Brief addressing Examiners objections/requirements under 37 CFR 1.192(c).

**(5) SUMMARY OF THE INVENTION**

The invention discloses a method for preventing the formation of thermally degraded photoresist residue on a semiconductor process wafer surface during a solder ball formation process (see e.g., Figures 2A-2F, Figures 3A-3C); paragraph 001; claims 1 and 11). More particularly, thermal degradation of a photoresist layer in contact with a

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semiconductor process wafer surface during a solder column (e.g., item 28A in Figure 3A) reflow process is avoided thereby eliminating the formation of thermally degraded photoresist residue and improving the reliability of subsequent processing steps (see paragraph 009).

The method as claimed in independent claim 1 includes forming a protective layer (e.g., item 24C in Figures 2D) on an exposed under bump metallization (UBM) contact layer (e.g., item 24B in Figure 2D), the protective layer comprising a resinous organic material having a glass transition temperature ( $T_g$ ) that is about greater than a solder reflow temperature; forming a patterned photoresist layer (e.g., item 26 in Figure 2E) including an opening overlying the UBM contact layer; forming a solder column (item 28A in Figure 3A) within the opening on the UBM contact layer; subjecting the solder column with the patterned photoresist in place to a first reflow temperature.

Independent claim 11 further specifies steps in the process including removing a portion of the protective layer within the opening to reveal the UBM contact layer prior to forming the solder column (e.g., see Figure 2F); removing remaining portions of the protective layer and the photoresist layer following the first reflow temperature process (see e.g., Figure 3B and removed

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item 24C in Figure 3A); and, subjecting the solder column to a second reflow temperature to form the solder ball (item 28B in Figure 3C.

**(6) ISSUES**

1. Is the rejection of claims 1, 3, 4, 8, and 10 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

2. Is the rejection of claim 2 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

3. Is the rejection of claim 21 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest



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APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

4. Is the rejection of claim 22 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

5. Is the rejection of claims 11, 12, 14-17, 19 and 24 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

6. Is the rejection of claim 13 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

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7. Is the rejection of claim 18 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

8. Is the rejection of claim 23 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

**(7) GROUPING OF CLAIMS**

The claims as grouped in a particular group with more than one claim stand and fall together. The claims do not stand and fall together between groups.

1. Group I: Claims 1-4, 8, and 10
2. Group II: Claim 2
3. Group III: Claims 21
4. Group IV: Claim 22

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- 5. Group V: Claims 11, 12, 14-17, 19 and 24
- 6. Group VI: Claim 13
- 7. Group VII: Claim 18
- 8. Group VIII: Claim 23

**(8) ARGUMENTS**

**Issue 1**

Is the rejection of claims 1, 3, 4, 8, and 10 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

Costas et al. disclose a 2-layer hermetic coating for on wafer encapsulation of GaAs monolithic microwave integrated circuits (MMIC) using benzocyclobutene (BCB) and ceramic materials for the coating to provide both mechanical protection and protection from moisture to the MMIC (see Abstract; col 2, lines 21-30). Costas et al. teach that the benefit of using BCB in the hermetic coating includes the fact that a low dielectric constant material is useful for capacitive decoupling of the underlying MMIC (see col 2, lines 33-44) as well as "reducing

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stress between the carrier and the substrate that often occurs during flip-chip mounting" (see Abstract).

Costas et al. disclose a method where a BCB (polymer) layer is first formed including removing the BCB layer from all bond pads and streets (exposed areas of implanted areas of the GaAs wafer) or other semi-insulating surface (see Figure 1; col 3, lines 34-45); forming an overlying ceramic layer followed by patterning a photoresist layer over the ceramic layer in an area where there is no BCB layer portion, followed by RIE etching to expose bonding pads (see col 3, lines 47-67) and surrounding areas (see Figure 3).

In contrast, APPELLANTS disclose and claim:

"A method for protecting a semiconductor process wafer surface from thermally degraded photoresist to improve a solder ball formation process comprising the steps of:

providing a semiconductor process wafer having a process surface comprising a passivation layer and an exposed UBM contact layer;

forming a protective layer over the passivation layer and the exposed UBM contact layer, the protective layer comprising a resinous organic material having a glass transition temperature (T<sub>g</sub>) that is about greater than a solder reflow temperature;

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forming a patterned photoresist layer on the protective layer, the patterned photoresist layer comprising an opening overlying the UBM contact layer;

forming a solder column within the opening on the UBM contact layer; and,

subjecting the solder column with the patterned photoresist in place to a first reflow temperature."

Rather, the method of Costas et al. works by a different principal of operation than APPELLANTS disclosed and claimed invention. For example, the solder bumps of Costas et al. are not formed within a patterned photoresist layer or on a under bump metallization (UBM) layer, but are rather, formed by an electroplating process on a bonding pad. Costas et al. does not disclose a protective layer as APPELLANTS have claimed, but rather disclose the formation of a benzocyclobutene (BCB) layer (discussed below under issue 2) formed for capacitive decoupling purposes and is formed to be about as thick as the solder columns of Costas et al. as seen e.g., at Figure 6, items 601 (solder column) and Figure 2, item 10 (BCB layer). While Examiner incorrectly equates the BCB layer of Costas et al. to the protective layer of APPELLANTS, the BCB layer of Costas et al. is not disclosed to have a protective function related to a solder column formation process as claimed by APPELLANTS. Rather, the

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method of Costas et al. relates to an entirely different structure and process. There is no process disclosed in Costas et al., of forming a patterned photoresist layer on a protective layer followed by a solder reflow process as claimed by APPELLANTS.

The fact that Costas et al. discloses that a BCB layer provides excellent resistance to mechanical damage during subsequent processing and during final assembly (col 4, lines 33-34), or resistance to moisture especially with an overlying ceramic layer (col 4, lines 28-30), as argued by Examiner, is largely irrelevant to the issue of obviousness of APPELLANTS invention, since Costas et al. do not disclose or teach APPELLANTS process. Examiner is clearly engaged in hindsight reasoning using Applicants disclosure as a roadmap to re-creating Applicants invention from the prior art.

Nowhere is it suggested in Costas et al. or in APPELLANTS presentation of the problem that a protective layer, including a BCB layer, can or should be used to solve the problem APPELLANTS have recognized and solved by their claimed invention.

Examiner cites APPELLANTS allegedly admitted prior art where in APPELLANTS disclosure in the background of the invention where

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the problem to be solved by APPELLANTS claimed invention is presented (see background of the invention paragraphs 006-008). Nowhere in APPELLANTS discussion of the problem presented is there a suggestion that a protective layer, as disclosed and claimed by APPELLANTS, could be used to protect a process wafer surface from the problem of thermally degraded photoresist created in a solder column reflow process.

APPELLANTS respectfully suggest that Examiner's motivation for combining Costas et al. with APPELLANTS disclosure is improperly gleaned solely from APPELLANTS disclosure. That is, there is no motivation independent from APPELLANTS disclosure, for combining APPELLANTS disclosure with Costas et al. to solve the problem that APPELLANTS have presented and solved by their disclosed and claimed invention.

Examiner cites *In re McLaughlin* for support for the proposition that "any judgment on obviousness is in a sense necessarily a reconstruction based on hindsight reasoning". Examiner, however, neglects the rest of the teachings of *In re McLaughlin*; "But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and **does not include knowledge gleaned only from the APPELLANTS disclosure**, such a

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reconstruction is proper" *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Nevertheless, assuming *arguendo* proper motivation for combination, such combination does not produce APPELLANTS claimed invention. Nowhere does APPELLANTS presentation of the problem to be solved or the teachings of Costas et al., alone or in combination, suggest, discuss or disclose APPELLANTS disclosed and claimed invention.

APPELLANTS point out that "we do not pick and choose among the individual elements of assorted prior art references to recreate the claimed invention, but rather we look for some teaching or suggestion in the references to support their use in a particular claimed combination" *Symbol Technologies, Inc. v. Opticon, Inc.*, 935 F.2d 1569, 19 USPQ2d 1241 (Fed. Cir. 1991).

"First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. **The teaching or suggestion to make the**



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**claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure."** *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

Lee, on the other hand, discloses a process whereby a BCB layer (incorrectly equated by Examiner with APPELLANTS protective layer), which is taught to have a low water intake rate and an excellent blocking effect against alpha particles, is formed **between an alpha particle source such as a solder ball and underlying sensitive integrated circuit devices.**

Lee does not teach a specific method for forming the solder balls and does not disclose or suggest APPELLANTS process of forming a solder column including carrying out a solder reflow processes on the solder column within a patterned photoresist

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layer where the photoresist layer overlies a protective layer as claimed and disclosed by APPELLANTS.

Lee teaches away from APPELLANTS disclosed and claimed invention by teaching various locations of the BCB layer (protective layer) (item 112 in Figures 4 through 9 which are variously taught as being formed between the metal redistribution layer and the solder ball e.g., Figure 4; having a polyimide layer between the BCB layer and the solder ball, Figure 5; a BCB layer between a polyimide layer and the solder ball, Figure 6; and, underlying the metal redistribution layer e.g., Figure 8.

Although there appears to be no motivation for combining Lee with Costas et al. (or APPELLANTS discussion of the prior art), Lee adds nothing alone or in combination with the previously cited and discussed references to produce APPELLANTS claimed invention. There is no recognition in Lee of the problem of thermally degraded photoresist residue on a wafer process surface in a solder ball or solder column formation process, nor is there any suggestion of a protective layer as APPELLANTS have disclosed and claimed. Moreover, there is no discussion at all of a solder column formation process within a patterned photoresist layer as APPELLANTS have disclosed and claimed. The various disclosed positions of the BCB layer in the method of Lee would not, and

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could not, function as a protective layer as APPELLANTS have disclosed and claimed.

The fact that Costas et al. disclose the use of a BCB layer for its dielectric properties (as well as associated mechanical properties) in a process unrelated to APPELLANTS disclosed and claimed invention, and Lee discloses use of a BCB layer for blocking alpha particle in a process unrelated to either Costas et al. or APPELLANTS disclosed and claimed invention, is clearly insufficient to make out a *prima facie* obvious.

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

APPELLANTS respectfully suggest that Examiner has engaged in impermissible hindsight reasoning using knowledge gleaned from APPELLANTS disclosure as a roadmap to recreate APPELLANTS claimed invention. Nevertheless, Examiner has failed to produce APPELLANTS claimed invention by combining the cited references, including APPELLANTS alleged admitted prior art, where such references alone or in combination completely lack a teaching for

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doing what APPELLANTS have done and accomplished by their disclosed and claimed invention.

"Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art." *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 1 USPQ2d 1941 (Fed. Cir. 1992).

## Issue 2

APPELLANTS reiterate the arguments made above under Issue 1. In addition, the BCB layer in either Costas et al. or Lee is nowhere taught or suggested as a **protective layer** as claimed by APPELLANTS. The purpose of the BCB layer in Costas et al. is as an encapsulant to reduce capacitive coupling. In the method of Lee, the BCB layer functions as an alpha particle blocker (e.g., see Abstract). The cited references, individually, or in combination, fail to recognize the problem that APPELLANTS have recognized and solved and clearly fail to disclose or suggest APPELLANTS disclosed and claimed invention, including APPELLANTS protective BCB layer.

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APPELLANTS respectfully suggest that Examiner misapprehends APPELLANTS disclosed and claimed invention by suggesting that the disclosure of Costas et al. is "equivalent to forming of solder columns through a patterned resist stencil either (1) of photosensitive Benzocyclobutene (BCB) or (2) with underlying non-photosensitive BCB, which has been patterned through the resist stencil." While APPELLANTS do not agree with Examiners assertion, nevertheless, APPELLANTS do not claim what Examiner asserts the disclosure of Costas et al. is equivalent to.

The BCB layer as disclosed and taught in Costas et al. or Lee, individually or in combination, would not accomplish the purpose of APPELLANTS disclosed and claimed invention.

### **Issue 3**

Is the rejection of claim 21 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

APPELLANTS reiterate the statements made above with respect to Issue 1 above.

Significantly, APPELLANTS disclosed and claimed invention teaches **removing remaining portions** of the protective layer following the first solder reflow and prior to a second solder reflow to form a solder ball.

However, in both the methods of Costas et al. and Lee portions of the BCB layer (incorrectly equated by Examiner with APPELLANTS protective layer) **remain in place, becoming part of the completed device**. In the method of Costas et al., the BCB layer remains in place as a capacitive decoupling encapsulating material (see e.g., col 2, lines 30-44, col 5, lines) 12-15). In the method of Lee, portions of the BCB layer **remain in place** becoming an alpha particle blocker (e.g., see Abstract).

Moreover, neither Lee nor Costas et al., individually or in combination teach **removing** a protective layer (e.g., BCB layer) prior to a second, solder ball forming, reflow temperature, thereby being inconsistent with, the principal of operation of APPELLANTS disclosed and claimed invention. APPELLANTS step of "removing remaining portions of the protective layer and photoresist layer" would destroy the structural relationship and purposes of the methods and structures disclosed by both Costas et al. and Lee.

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"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious." *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

#### **Issue 4**

Is the rejection of claim 22 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

APPELLANTS reiterate the statements made above with respect to Issue 1, above. Further, none of the cited references alone or in combination suggests or discloses APPELLANTS disclosed and claimed invention including:

"wherein an oxygen ashing process is carried out to remove the protective layer at the bottom of the opening to reveal the UBM contact layer prior to the step of forming the solder column."

As previously pointed out under Issue 3, the BCB layer of Costas et al. and Lee et al., (incorrectly equated by Examiner with APPELLANTS protective layer), remain as part of a completed device in the structures and processes of Costas et al. and Lee et al., therefore being inconsistent with APPELLANTS disclosed and claimed ashing step and destroying the structural relationship and purposes of the methods and structures disclosed by both Costas et al. and Lee, individually or in combination.

#### Issue 5

Is the rejection of claims 11, 12, 14-17, 19 and 24 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

APPELLANTS reiterate the statements made above with respect to Issues 1 and 3 above. As previously pointed out under Issue 3, both Lee and Costas et al. do not teach a protective layer that is eventually removed at the end of the disclosed process, but rather, teach a BCB layer **which remains a part of the completed device** and is formed in an entirely different



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structural relationship and for entirely different purposes than APPELLANTS disclosed and claimed invention.

The methods of Costas et al. and Lee, (as well as APPELLANTS discussion of the prior art), either individually or in combination, are inconsistent with APPELLANTS disclosed process steps. APPELLANTS disclosed process steps and would destroy the principal of operation of the disclosed structure and processes of Costas et al. and Lee. Likewise, the disclosed structure and processes of Costas et al. and Lee, either individually or in combination, would destroy the purpose and operation of APPELLANTS disclosed and claimed invention.

The methods of both Costas et al. and Lee, individually or in combination, are inconsistent APPELLANTS claimed steps of:

"removing a portion of the protective layer within the opening to reveal the UBM contact layer;

forming the solder column on the UBM contact layer;

subjecting the solder column to a first reflow temperature;

**removing remaining** portions of the protective layer and the photoresist layer; and,

**subjecting the solder column to a second reflow temperature** to form the solder ball."

**Issue 6**

Is the rejection of claim 13 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

APPELLANTS reiterate the statements made above with respect to Issues 2 and 5 above.

**Issue 7**

Is the rejection of claim 18 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

APPELLANTS reiterate the statements made above with respect to Issue 5 above. Further, none of the cited references alone or in combination suggests or discloses APPELLANTS disclosed and claimed invention including:

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"wherein the step of removing comprises a wet chemical stripping process"

APPELLANTS wet stripping process would destroy the BCB layer (incorrectly equated by Examiner with the protective layer of APPELLANTS) of Costas et al. and Lee, either individually or in combination.

#### **Issue 8**

Is the rejection of claim 23 under 35 USC § 103(a) as being unpatentable over Costas et al. (U.S. Patent 6,137,125) in view of admitted prior art and further in view of Lee (US U.S. Patent 6,410,414) proper when such references do not teach or suggest APPELLANTS claimed invention or recognize or solve a problem that APPELLANTS have recognized and solved by their claimed invention?

APPELLANTS reiterate the statements made above with respect to Issue 5, above. Further, none of the cited references alone or in combination suggests or discloses APPELLANTS disclosed and claimed invention including:

"wherein the step of removing a portion of the protective layer comprises an oxygen ashing process"

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APPELLANTS oxygen ashing process process would destroy the BCB layer (incorrectly equated by Examiner with the protective layer of APPELLANTS) of Costas et al. and Lee, either individually or in combination.

### **CONCLUSION**

Examiner has not met the burden of establishing a *prima facie* case of obviousness. Moreover, the fact that none of the cited references, either individually or in combination, recognizes the problem that APPELLANTS have recognized, or provides a solution thereto as APPELLANTS have disclosed and claimed, demonstrates the non-obviousness of APPELLANTS disclosed and claimed invention.

None of the cited references, individually or in combination, recognizes or solves the problem of thermal degraded photoresist in a solder column or solder ball formation process. The fact that Examiner can produce no reference or combination of references disclosing or suggesting APPELLANTS disclosed and claimed invention strongly supports a conclusion of nonobviousness.

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It is therefore respectfully submitted that Examiners final rejection of APPELLANTS claims is improper under the statutory standard of 35 USC § 103(a) as interpreted by both the Board and the Courts.

The reversal of the final rejection is respectfully solicited from the Board.

Respectfully submitted,

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**CLAIM APPENDIX**

1. A method for protecting a semiconductor process wafer surface from thermally degraded photoresist to improve a solder ball formation process comprising the steps of:

providing a semiconductor process wafer having a process surface comprising a passivation layer and an exposed UBM contact layer;

forming a protective layer over the passivation layer and the exposed UBM contact layer, the protective layer comprising a resinous organic material having a glass transition temperature (T<sub>g</sub>) that is about greater than a solder reflow temperature;

forming a patterned photoresist layer on the protective layer, the patterned photoresist layer comprising an opening overlying the UBM contact layer;

forming a solder column within the opening on the UBM contact layer; and,

subjecting the solder column with the patterned photoresist in place to a first reflow temperature.

2. The method of claim 1, wherein the glass transition temperature (T<sub>g</sub>) is greater than about 300 degrees Centigrade.

3. The method of claim 1, wherein the protective layer comprises Benzocyclobutene.

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4. The method of claim 1, wherein the glass transition temperature (T<sub>g</sub>) is greater than about 350 degrees Centigrade.

5. - 7. (cancelled)

8. The method of claim 1, wherein the solder column comprises a lead content of greater than about 90 weight percent.

9. (cancelled)

10. The method of claim 1, wherein the protective layer is removable by at least one of reactive ion etching and wet chemical stripping.

11. An improved method for forming a solder ball to avoid photoresist residue in a solder ball formation process comprising the steps of:

providing a semiconductor wafer process surface comprising an under bump metal (UBM) contact layer for forming a solder ball thereover;

forming a protective layer overlying the semiconductor wafer process surface comprising the UBM contact layer, said protective layer comprising a resinous organic material having a glass transition temperature (T<sub>g</sub>) that is greater than a solder column reflow temperature;

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forming a patterned photoresist layer over the protective layer, the patterned photoresist layer comprising an opening for containing the solder column overlying the UBM contact layer;

removing a portion of the protective layer within the opening to reveal the UBM contact layer;

forming the solder column on the UBM contact layer;

subjecting the solder column to a first reflow temperature;

removing remaining portions of the protective layer and the photoresist layer; and,

subjecting the solder column to a second reflow temperature to form the solder ball.

12. The method of claim 11, wherein the glass transition temperature ( $T_g$ ) is greater than about 300 degrees Centigrade.

13. The method of claim 11, wherein the protective layer comprises Benzocyclobutene.

14. The method of claim 11, wherein the glass transition temperature ( $T_g$ ) is greater than about 350 degrees Centigrade.

15. The method of claim 11, wherein the solder column includes a lead content of greater than about 90 weight percent.



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16. The method of claim 11, wherein the UBM contact layer forms an uppermost under bump metal layer (UBM), wherein the UBM layer is selected from the group consisting of titanium, copper, and nickel.

17. The method of claim 11, wherein the protective layer is removable by at least one of reactive ion etching and wet chemical stripping.

18. The method of claim 11, wherein the step of removing comprises a wet chemical stripping process.

19. The method of claim 11, wherein the step of providing a semiconductor wafer process comprises depositing a UBM masking photoresist layer over the UBM contact layer followed by reactive ion etching to reveal a passivation layer surrounding the UBM contact layer.

20. (cancelled)

21. The method of claim 1, further comprising the steps of:  
removing remaining portions of the protective layer and photoresist layer; and,

subjecting the solder column to a second reflow temperature to form a solder ball.

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22. The method of claim 1, wherein an oxygen ashing process is carried out to remove the protective layer at the bottom of the opening to reveal the UBM contact layer prior to the step of forming the solder column.

23. The method of claim 11, wherein the step of removing a portion of the protective layer comprises an oxygen ashing process.

24. The method of claim 11, wherein the passivation layer is selected from the group consisting of silicon nitride and silicon oxide.